

SUBSTRATE CUTTING METHOD

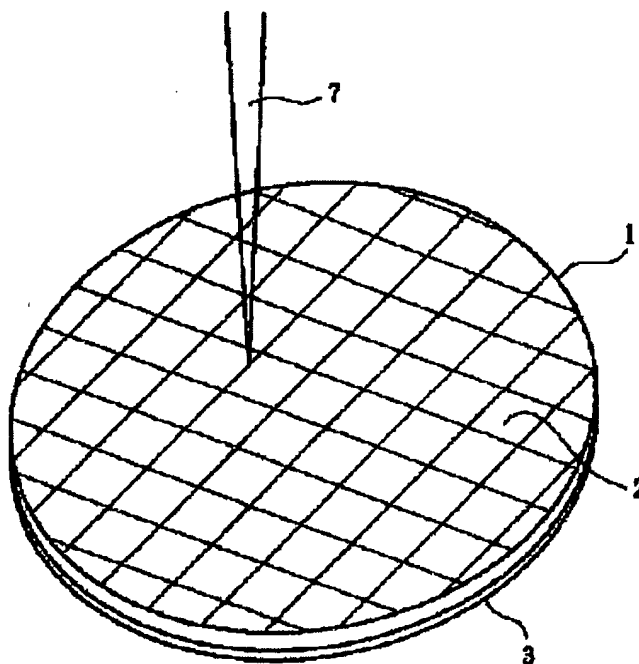
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Abstract of JP2002324768

PROBLEM TO BE SOLVED: To cut a substrate such as a semiconductor wafer without using a dicer nor an adhesive sheet. SOLUTION: The semiconductor wafer 1 where many elements 2 are formed is suctionally held on an x-y table 4 and irradiated with very short pulse laser light 7 whose pulse width is ≤ 1 picosecond along scribe lines between the elements 2 and 2, thereby cutting the wafer.



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CLAIMS

[Claim(s)]

[Claim 1] Substrate cutting process characterized by irradiating ultrashort pulse laser and cutting it to a substrate.

[Claim 2] Substrate cutting process according to claim 1 with which pulse width of said ultrashort pulse laser is characterized by being one or less picosecond.

[Claim 3] Substrate cutting process according to claim 1 or 2 characterized by irradiating said laser where the surface layer of a substrate is reformed.

[Claim 4] Substrate cutting process according to claim 1 to 3 with which the pulse separation of said ultrashort pulse laser are characterized by carrying out two or more pulse irradiation by 3 - 30 picosecond.

[Claim 5] Substrate cutting process according to claim 1 to 4 which said substrate is the semiconductor wafer in which many components were formed, and is characterized by irradiating ultrashort pulse laser along the scribe line between said components.

[Claim 6] Substrate cutting process according to claim 5 characterized by the thickness of said semiconductor wafer being 50 micrometers or less.

[Claim 7] Substrate cutting process according to claim 5 or 6 with which said semiconductor wafer is characterized by having the adhesives layer by which batch processing was carried out to the rear face.

[Claim 8] Substrate cutting process according to claim 5 to 7 with which the rear face of said semiconductor wafer is characterized by adsorbing the x-y table.

[Claim 9] Substrate cutting process according to claim 5 to 8 with which said laser is characterized by irradiating except for the circumference part of a wafer.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the substrate cutting process which carries out suitable, when cutting the semiconductor wafer in which many components were formed, about substrate cutting process and manufacturing a semi-conductor pellet.

[0002]

[Description of the Prior Art] They are many components (an integrated circuit is included.) to the semiconductor wafer generally sliced and ground from the ingot when a semiconductor device was manufactured. the following -- being the same -- after forming, carrying out die bonding of the pellet which cut and obtained this semiconductor wafer along the scribe line between said components to a leadframe etc. and performing wirebonding between a component and a lead further, mold is carried out by resin etc., and the leadframe etc. is divided and manufactured.

[0003] On the occasion of cutting of the above mentioned semiconductor wafer, as shown in drawing 10 and drawing 11, the wafer W in which many components P were formed was stuck on pressure sensitive adhesive sheet S, adsorption maintenance of the pressure sensitive adhesive sheet S was carried out with the adsorption hole H of the x-y table ST, dicing was carried out by the dicer D equipped with the diamond blade B along each components P and P and the scribe line between --, each component P was divided, and Pellet P has been obtained.

[0004] However, there were the following troubles in the approach of sticking Wafer W on pressure sensitive adhesive sheet S, and cutting by Dicer D as mentioned above.

[0005] Since the 1st is generated and proliferated and an ingredient defect is mechanically cut to it by Dicer D, a crack and a chipping arise for Wafer W or Component P at the time of cutting, and the yield of Pellet P falls to it. And on appearance, although a clear crack and a clear chipping detect and the image pick-up with a camera etc. can remove them The micro crack produced inside is difficult to detect depending on the image pick-up from the outside. Since it becomes poor at the characteristic inspection after an assembly etc., the futility of clue materials, such as adhesives, a heat sink, etc. at the time of die bonding, and a wire at the time of wirebonding, not only arises, but it produces futility by performing unnecessary process processing, such as a time amount loss, and electrical and electric equipment, gas.

[0006] Since frictional heat is produced, cutting by Dicer D has unescapable cooling, and since scraps are generated by dicing, in order to flush this, it needs a lot of cooling water for the 2nd at the time of dicing. moreover, the cooling water sake -- equipment -- watertight construction -- it must carry out -- equipment -- complication -- and it large-sum-zizes.

[0007] Although the demand of thin semiconductor devices, such as a solar battery, an IC card, and a stack type semiconductor device, is increasing [3rd] recently, in case it is not only easy to damage Wafer W by the thrust at the time of sticking Wafer W on pressure sensitive adhesive sheet S, but Pellet P will be exfoliated from pressure sensitive adhesive sheet S after cutting since the mechanical strength falls if Wafer W is thin-shape-ized in order to cope with the demand of such thin-shape-izing, it is easy to damage Pellet P.

[0008] Therefore, the manufacture approach called point dicing as shown in drawing 12 (A) - (D) for thin-shape-izing of Pellet P is developed. This approach forms many components P in the front-face the wafer W of the comparatively thick thickness t1 (for example, 500 micrometers, side a. After sticking the rear face b on the 1st pressure sensitive adhesive sheet S1, carrying out the dicing of (A) and the wafer W along the scribe line between Components P and P from a front-face a side and forming the slot G of the predetermined depth, the pressure sensitive adhesive sheet S1 of (B) and a rear face is removed. When only the thickness t3 exceeding the slot G which stuck the 2nd pressure sensitive adhesive sheet S2, and formed the (C) and rear-face b side in the front-face a side by said dicing carries out grinding removal shortly It divides into each pellet P and P-- at the same time it forms the thin-shape-ized rear face c, and the pellet P of the request thickness t2 (for example, 30-50 micrometers) is obtained (D).

[0009] However, the manufacture approach called this point dicing is complicated, and a manufacturing cost soars. Moreover, in case Pellet P is exfoliated from a pressure sensitive adhesive sheet S2, there is no change in being easy to damage Pellet P.

[0010] As shown [4th] in drawing 13 (A) - (D), the adhesives layers AD, such as solder and resin, are beforehand formed in the rear face of Wafer W by batch processing, and the adhesives layer AD side is stuck on pressure sensitive adhesive sheet S. (A), After dicing's cutting on each pellet P and obtaining (B) and the pellet P which exfoliates each pellet P from pressure sensitive adhesive sheet S, and has the adhesives layer AD at the rear face, (C), The manufacture approach by the package adhesives layer which carries out die bonding of the pellet P to the heat sinks R, such as a leadframe, using the adhesives layer AD on the back is also developed (D).

[0011] Since this approach does not need to supply adhesives to a heat sink R one by one at the time of die bonding Since die bonding becomes easy and the adhesives layer AD of the pellet P by which it not only can perform time amount compaction of a die bonding process, but bonding was carried out to the heat sink R becomes uniform thickness Although the height adjustment of the complicated bonding tool for every bonding part becomes unnecessary and wirebonding is quickness and the manufacture approach which becomes easily and certain in a next wirebonding process since the height of a bonding location becomes fixed Depending on the manufacture approach of thin-shape-izing of the pellet P called the above-mentioned point dicing, the adhesives layers AD, such as solder and resin, are beforehand formed in the rear face of Wafer W, and such a pellet P that has the adhesives layer AD at the rear face cannot be obtained. Moreover, when the adhesives layer AD is

formed by elasticity material, such as solder, adhesives carry out blinding to Blade B, and dicing is not made well.

[0012] The approach of using Dicer D for the 5th, by carrying out horizontal migration of the x-y table which carried out adsorption maintenance of the wafer W, with the blade height held, after setting up the height of Blade B in the location from which it separated from the wafer W location. Since both-way actuation of the blade is carried out from the method of the outside of an end of Wafer W to the method of the outside of the other end, the dicing of the wafer W is carried out and many non-forward type pellets arise into the circumference part of Wafer W, sorting with a forward type pellet and a non-forward type pellet is needed, and the processing is complicated.

[0013]

[Problem(s) to be Solved by the Invention] Then, as Wafer W is replaced with cutting mechanically by the dicer D which has the diamond blade B and it is shown in drawing 14 (A) - (C) The CW laser of a CO₂ laser or an YAG laser and the long pulse laser L are irradiated along the scribe line between the pellets P and P of Wafer W. (A), It considers carrying out melting scattering of the laser radiation part, forming Slot G, making Slot G penetrate to a rear face by repeating (B) and Laser L and irradiating them, and cutting Wafer W (C).

[0014] However, since such laser L is large, a continuous wave or pulse width Carry out a temperature rise near the laser radiation part by heat conduction at the time of laser radiation, and a thermal strain occurs to Wafer W. Since it not only becomes the cause of a crack or micro crack initiation, but heating melting is carried out to near the exposure section of Laser L and the fusion part disperses together according to the rapid scattering force of the melt of the exposure part of Laser L, The width of face w of the slot G formed becomes an ununiformity greatly, and moreover, since whenever [tilt-angle / of the slot G] is small, they are Components P and P. -- The scribe line width of face of a between must be set up greatly, and pellet yield becomes low. And it deposits on the fused edge of wafer ingredient fang furrow G, or it scatters near the laser radiation section and the electrode of Component (pellet) P etc. is covered. Moreover, since also whenever [tilt-angle / of the side edge side P of the pellet P obtained] was small, there was a trouble that it may become trouble depending on the application of Pellet P.

[0015] Therefore, this invention aims at offering the cutting process which solved the above-mentioned conventional trouble in the substrate cutting process which irradiates laser.

[0016]

[Means for Solving the Problem] Substrate cutting process indicated by claim 1 of this invention is characterized by irradiating ultrashort pulse laser and cutting it to a substrate.

[0017] Drawing 4 is the configuration block Fig. of ultrashort pulse laser equipment. Here, if it is going to amplify a titanium sapphire laser output as it is, since peak intensity will become high too much and an optical element will be damaged, the chirp pulse amplifying method is used. As it is indicated in drawing 5 as the chirp pulse amplifying method, ((pulse compression) 3) techniques which amplify where it extends pulse width to thousands or more times (pulse elongation) and (1) and peak power are kept low at them, and are again compressed into the original pulse width by the diffraction-grating pair ((pulse magnification) 2) and after that are said by carrying out the frequency chirp of the pulse width of the ultrashort pulse laser TL which carries out incidence to the above-mentioned regenerative amplifier RA using a diffraction-grating pair. The pulses finally amplified are energy 2mJ, pulse width 130fs, and 10Hz of recurrence rates, and peak intensity is amplified to 15GW. It means that it was amplified about 100,000 times since the peak intensity of titanium sapphire laser was 107kW.

[0018] Since a material cost is not only reducible, but [since the conventional pressure sensitive adhesive sheet is unnecessary and it can omit,] the substrate cutting process which irradiates ultrashort pulse laser does not scatter according to the force with a mechanical pellet at the time of cutting unlike mechanical cutting by the dicer equipped with a diamond blade and attachment processes are reducible, a process cost can be reduced. Moreover, since it is a dry process, a washing process can be skipped. Furthermore, ultrashort pulse laser is compared with the approach of irradiating the CW laser and pulse laser L of the conventional CO₂ laser or an YAG laser, and cutting Wafer W. Since heat conduction is small since the pulse width of laser is small, and there is almost no substrate temperature rise near the laser radiation part The yield fall resulting from the crack initiation by the thermal strain by the temperature rise of a substrate is lost, and since a narrow slot can be formed only in the part which irradiated laser, the width of face of a scribe line can also be designed small, and can increase the element number per substrate. And since it also decreases that the fused substrate ingredient scatters near the laser radiation section, yield of a pellet can be made high.

[0019] That is, the thermal diffusion length LD at the time of laser radiation can express the diffusion coefficient of an ingredient with $LD = (D\tau)^{1/2}$, when pulse width of D and laser is set to τ . Here, it is $D = kT / \rho c_p$ and kT, ρ , and c_p are thermal conductivity, a consistency, and heat capacity, respectively. Therefore, the thermal diffusion length LD can disregard most thermal diffusion, if ultrashort pulse laser is irradiated, it will compare with the former, the thermal diffusion length at the time of laser radiation will become very small and pulse width will become below a picosecond, since it is proportional to the square root of pulse width τ .

[0020] Substrate cutting process of this invention according to claim 2 is characterized by the pulse width of said ultrashort pulse laser being one or less picosecond.

[0021] By irradiating the femtosecond pulse (wavelength of 800nm) of for example, the source of titanium sapphire laser the pulse width of whose is one or less picosecond according to a substrate cutting process given in above-mentioned claim 2 As shown in drawing 6 (A), when laser 7 is irradiated at a substrate 1, there is almost no temperature rise near the exposure part of laser 7. Therefore, by being able to form the slot 8 where the side face rose steeply only into the exposure part of the laser 7 as shown in drawing 6 (B), and irradiating laser 7 on the repeat frequency of 1kHz - 100kHz The pellet 2 which has side edge side 2a which does not almost have an inclination as shown in drawing 6 (C) is obtained. Therefore, the aspect ratio of a slot 8 can be high, can set up small the scribe line width of face of a substrate 1, and can increase the number of the pellet 2 per substrate, and the yield of a pellet 2 can be improved. As compared with drawing 14 (A) - (C) which is the substrate cutting process by the conventional laser and which was mentioned above, the difference makes this clear. Moreover, it also decreases that there is almost no temperature rise of a substrate, and the fused substrate ingredient accumulates or scatters near the laser radiation section.

[0022] Substrate cutting process indicated by claim 3 of this invention is characterized by irradiating said laser, where the surface layer of a substrate is reformed.

[0023] Since laser is irradiated in the state of reforming to which the temperature of the surface layer of a substrate was raised and laser transmittance was reduced according to a substrate cutting process given in above-mentioned claim 3, the laser absorption coefficient of the surface layer by which reforming was carried out becomes high, and process tolerance can be improved.

[0024] It is characterized by the pulse separation of said ultrashort pulse laser carrying out two or more pulse irradiation of the substrate cutting

process indicated by claim 4 of this invention by 3 - 30 picosecond.

[0025] According to a substrate cutting process given in above-mentioned claim 4, it is controlled that the scattering particle by the pulse irradiation of precedence carries out the reattachment to the perimeter of a hole by consecutive pulse irradiation, and it can make small the climax height dimension of the perimeter of a hole.

[0026] The substrate cutting process indicated by claim 5 of this invention is the semiconductor wafer with which said substrate formed many components, and it is characterized by irradiating said ultrashort pulse laser along the scribe line between said components.

[0027] When according to a substrate cutting process given in above-mentioned claim 5 pellet yield can be remarkably improved since scribe line width of face between components can be narrowed as mentioned above, and it not only can increase, but neither a crack nor a chipping produces the pellet number per semiconductor wafer on a pellet, pellet reinforcement can also improve.

[0028] Substrate cutting process indicated by claim 6 of this invention is characterized by the thickness of said semiconductor wafer being 50 micrometers or less.

[0029] According to a substrate cutting process given in above-mentioned claim 6, it can manufacture, without adopting the manufacture approach called point dicing in the semiconductor device which has a thin-shape-ized pellet like the high IC card of a demand, or a stack type recently.

[0030] It is characterized by the substrate cutting process indicated by claim 7 of this invention having the adhesives layer by which batch processing of said semiconductor wafer was carried out to the rear face.

[0031] Since the pellet obtained by cutting of a semiconductor wafer has the adhesives layer by which batch processing was carried out to the rear face according to a substrate cutting process given in above-mentioned claim 7 By having the adhesives layer of uniform thickness at the rear face it not only can omit the complicated activity which supplies adhesives, such as solder and resin, to a leadframe etc. one by one, but [in case die bonding is carried out to a leadframe etc.,] It is lost that the pellet by which die bonding was carried out to the leadframe etc. inclines, and it sets at a next wirebonding process. The complicated activity of adjusting the height of a bonding tool for every bonding part when a bonding height location becomes fixed is unnecessary. A bonding activity not only becomes easy, but the bond strength of each bonding part becomes fixed, and a property is acquired for homogeneity and the outstanding semiconductor device.

[0032] It is characterized by the substrate cutting process indicated by claim 8 of this invention being adsorbed by the x-y table in the rear face of said semiconductor wafer.

[0033] According to a substrate cutting process given in above-mentioned claim 8, at the time of cutting, since the semiconductor wafer adsorbs with the vacuum suction force electrostatic by the x-y table The case where two or more pellets are collectively transferred to a tray etc. after cutting since the alignment condition of the component at the time of a wafer can be made to hold on the pellet after cutting, Or it is also easily realizable to carry out the sequential pickup of the pellet after cutting from a x-y table, and to carry out die bonding to a direct leadframe etc.

[0034] Substrate cutting process indicated by claim 9 of this invention is characterized by irradiating said laser except for the circumference part of a semiconductor wafer.

[0035] Since according to a substrate cutting process given in above-mentioned claim 9 it can shorten laser radiation time amount so much since laser is not irradiated at the circumference part of a semiconductor wafer, and the circumference part of a wafer is not cut a throughput not only can improve, but and the non-forward type pellet of a large number by the non-forward type component in a wafer circumference part like the cutting process using a dicer does not arise, the processing is unnecessary and manufacture becomes easy.

[0036]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 shows the outline block diagram for explaining the substrate cutting process of this invention. In drawing 1, the thickness as an example of a substrate is a semiconductor wafer (henceforth a wafer) 50 micrometers or less, many components 2 are formed of well-known impurity diffusion etc., and, as for 1, the adhesives layer 3 by batch processing, such as solder and resin, is formed in the rear face. As the rear face (adhesives layer 3 side) of this wafer 1 is shown in drawing 2, without being stuck on a pressure sensitive adhesive sheet, the x-y table 4 is adsorbed. Electrostatic adsorption is sufficient as the adsorption by this stage 4, and vacuum adsorption is sufficient, and especially when the dimension of a component 2 is comparatively large, as shown in drawing 2, corresponding to each component 2 formed in the wafer 1, you may have two or more adsorption holes 5 and bulbs 6. In addition, what is necessary is to constitute possible [division of the upper part of the x-y table 4], to prepare two or more upper parts from which the pitch of the adsorption hole 5 differs, and just to exchange the upper part according to a form change, in order to correspond to the wafer 1 of many forms.

[0037] Thus, along the component 2 of the wafer 1 by which the stage 4 was adsorbed, and the scribe line between two, by 1kHz - 100kHz, the pulse width by the source of titanium sapphire laser repeats the femtosecond laser 7 of one or less picosecond, and irradiates and cuts it. Then, as above-mentioned drawing 6 (A) - (C) explained, the slot 8 where the side edge side rose steeply is formed, as shown in drawing 3, side edge side 2a is a right angle-like mostly, and the pellet 2 of a large number which have the adhesives layer 3 by batch processing at the rear face is obtained.

[0038] Therefore, the die bonding of the pellet 2 can be carried out, without supplying adhesives to a heat sink R, as mentioned above if die bonding of this pellet 2 is carried out to the heat sinks R (refer to drawing 13 (D)), such as a leadframe, using that adhesives layer 3. And when it does in this way and die bonding of the pellet 2 is carried out to a heat sink R Since an inclination is not generated on a pellet 2 as compared with what supplied adhesives to the heat sink and carried out die bonding of the pellet according to the thickness of the adhesives layer 3 on the back being uniform In a next wirebonding process, can exclude the complicated activity which adjusts the height of a bonding tool for every bonding part, and a BONDING activity becomes easy. It not only can perform time amount compaction of a bonding activity, but in the bond strength of each bonding part, since it can do greatly, homogeneity and the semiconductor device fixed [a property's] are obtained.

[0039] In addition, although the exposure of the laser 7 to a wafer 1 may be performed from the end of a wafer 1 to the other end along a component 2 and the scribe line between two, as shown in drawing 7 If it is made to irradiate only the field part except surrounding non-forward type component partial (mesh part in drawing) 1a of a wafer 1, since the non-forward type pellet by the non-forward type component of a circumference part will not arise, there is an advantage that next processing becomes easy.

[0040] Moreover, the surface layer of a wafer 1 may be reformed at the time of the exposure of laser 7. That is, if the transmittance of laser 7

changes and temperature becomes high with the temperature, laser transmittance will fall and the absorption coefficient of a substrate of laser 7 will improve. For example, with a metal, reforming of a surface layer with a depth of 4-5 micrometers is made in a depth of 1-5nm, and silicon. Reforming of this surface layer can be carried out with heating of the surface layer of a wafer 1. This heating may also embed a heater to the interior of the x-y table 4, and may irradiate laser 7, after carrying out the preheating of the wafer 1 with a hot plate beforehand, and while obscuring the focus other than the laser head for laser 7 of the ultrashort pulse for cutting which focused, or preparing a continuous wave or the laser head for reforming with large pulse width, irradiating the laser for reforming and reforming the surface layer of a wafer 1 the laser 7 for cutting -- coincidence -- or it gets mixed up, and it irradiates and you may make it cut

[0041] In addition, like [in case heating which performs reforming of the surface layer of this wafer 1 irradiates the laser L with large conventional continuous wave or pulse width], since it is different from that to which the temperature rise of the laser radiation part is carried out with high power and heat conduction does not produce a thermal strain small, either, rapid and a possibility that a crack and a micro crack may arise are not.

[0042] As for the pulse separation of the ultrashort pulse laser irradiated by this invention, considering as 3 - 30 picosecond is desirable. Hereafter, the reason is explained in full detail using the experimental result by the double pulse which gave predetermined pulse separation.

[0043] The substrate for experiment condition cutting: A silicon substrate, the count N:18 of thickness dimension ultrashort pulse [of 50 micrometers] laser:wavelength [titanium sapphire laser pulse width tau:120fs core] pulse ERERUGI [of lambda:800nm] E focal distance [:0.01 mJ/pulse work distance W.D.:100mm lens] the laser radiation of f:100mm [0044] When pulse separation exceeded [each pulse energy of the above-mentioned ultrashort pulse laser] 3 picoseconds in the double pulse of 0.01 mJ/pulse, the climax configuration of the perimeter of a hole began to become gently-sloping gradually, pulse separation rose by 10 - 20 picosecond, height became min, and the height dimension was reduced to 0.5 micrometers or less. However, when pulse separation exceeded 30 picoseconds, climax height increased gradually again. It rises with pulse separation and relation with a height dimension is shown in drawing 8 .

[0045] If pulse separation exceed 3 picoseconds, scattering of the particle by evaporation will start after 3 picoseconds of the 1st pulse irradiation, the 2nd pulse will be irradiated by the particle, and the phenomenon in which the climax configuration of the perimeter of a hole begins to become gently-sloping will be considered for the effectiveness which controls carrying out the reattachment to the perimeter of a hole to show up.

[0046] The scattering grain density by the 1st pulse is the highest at after [the 1st pulse irradiation] 10 - 20 picosecond, and it is thought of for the 2nd pulse to prevent the reattachment around [hole] a scattering particle effectively that pulse separation rise by 10 - 20 picosecond, and a height dimension serves as min.

[0047] Furthermore, when the 2nd pulse carries out incidence to the hole front face formed of the 1st pulse, after pulse energy decreases by absorption by the scattering particle, it is assumed that the thin melting layer has spread in the hole front face, the absorption coefficient to the 2nd pulse becomes large, the melting layer by the 2nd pulse decreases further from the time of independent pulse irradiation, and decreasing climax is also considered.

[0048] If pulse separation become 30 picoseconds, since a scattering particle begins to adhere to the perimeter of a hole as debris toward convergence, the ablation by the 1st pulse will be considered that a climax height dimension starts to increase.

[0049] If pulse separation spread to 50 picoseconds, the scattering grain density which exists on the optical axis of the 2nd pulse will decrease, and the energy loss of the 2nd pulse will decrease. Furthermore, in order that the absorption coefficient on the front face of a hole by the 1st pulse may also approach a steady state, it is thought that the processing depth has started to increase.

[0050] Moreover, the spot configuration of the ultrashort pulse laser irradiated by this invention can be set as the arbitration of drawing 9 (A) - (C). That is, when irradiating the circle configuration spot sp1 as shown in drawing 9 (A), only a dimension l1 can be processed by one shot of laser, and it becomes the exposure pitch p1 and the processing width of face w1. Since it is set to l2 and it can do more greatly than the dimension l1 in the case of the above-mentioned circle configuration spot sp1, and the dimension which can be irradiated by one shot of laser as compared with the case of the circle configuration spot sp1 shown in above-mentioned drawing 9 (A) is made more greatly than the above p1 and can do the exposure pitch p2 when it is made the ellipse form spot sp2 as shown in drawing 9 (B), working speed can be improved. In addition, when laser power is the same, the processing width of face w2 becomes smaller than the case of the circle configuration spot sp1 of drawing 9 (A). Therefore, it is effective to make processing width of face small. Furthermore, as shown in drawing 9 (C), when it is made the ellipse form spot sp3 which made only the include angle theta incline, there is an advantage that the processing width of face w2 ($=l2 \sin \theta$) can be set as arbitration, by changing theta whenever [tilt-angle].

[0051] Moreover, in this invention, the electrode for dust collection which carried out the electric charge to plus or minus near the laser radiation section may be arranged. If it does in this way, electrostatic adsorption of the electrified fragmentation generated by laser radiation can be carried out with the electrode for dust collection, and it can prevent that the electrified fragmentation accumulates near the laser radiation section.

[0052]

[Effect of the Invention] Since it is characterized by irradiating the substrate cutting process of this invention and cutting ultrashort pulse laser to a substrate, when sticking on a pressure sensitive adhesive sheet becomes unnecessary as compared with the approach of carrying out dicing using the dicer equipped with the diamond blade, neither a crack nor a chipping arises with cutting but pellet reinforcement can be enlarged, the cooling water for cooling at the time of cutting and cutting waste washout becomes unnecessary. Moreover, manufacture of the thin pellet according to the demand of thin-shape-izing and the pellet which has the adhesives layer which carried out batch processing to the rear face is also attained. Furthermore, since only the exposure part of laser could be heated and cut as compared with the approach of irradiating the CW laser of the conventional CO2 laser or an YAG laser, and a pulse laser with big pulse width, and cutting Wafer W, and it was hard coming to generate the micro crack by the thermal strain and will be steeply risen by the side edge side of a cutting slot, width of face of a scribe line can be narrowed and the pellet yield per substrate can be improved.



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(12) United States Patent
Sawada**(10) Patent No.: US 6,770,544 B2**
(45) Date of Patent: Aug. 3, 2004**(54) SUBSTRATE CUTTING METHOD****(75) Inventor: Hiroshi Sawada, Kusatsu (JP)****(73) Assignee: NEC Machinery Corporation,**
Shiga-Ken (JP)**(*) Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.**(21) Appl. No.: 10/084,761****(22) Filed: Feb. 20, 2002****(65) Prior Publication Data**

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H01L 21/301**(52) U.S. Cl. 438/462; 438/463****(58) Field of Search 438/462, 463,**
438/FOR 386**(56) References Cited****U.S. PATENT DOCUMENTS**

3,824,678 A * 7/1974 Harris et al. 219/121.73

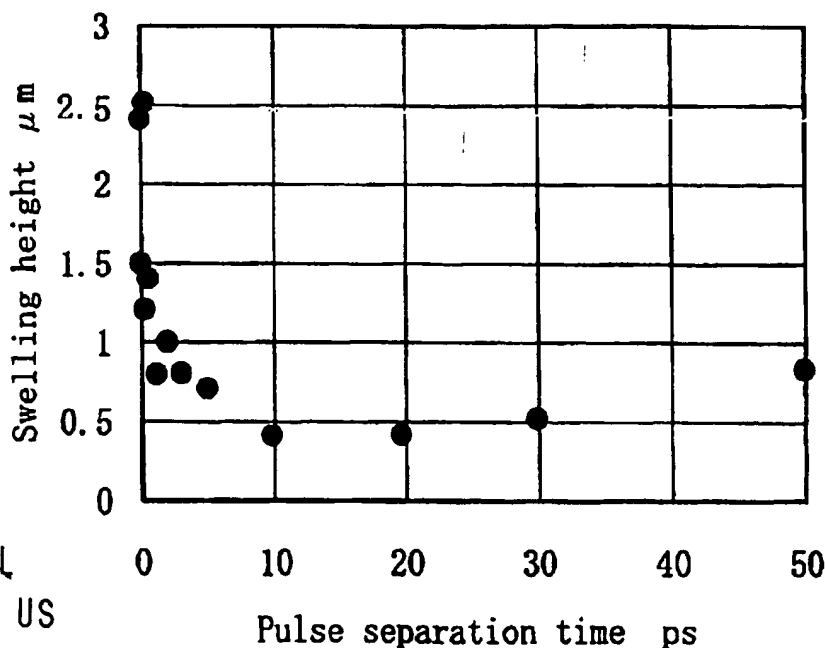
4,169,976 A * 10/1979 Cirri 219/121.72
5,916,460 A * 6/1999 Imoto et al. 219/121.67
6,159,832 A * 12/2000 Mayer 438/584
6,261,919 B1 * 7/2001 Omizo 438/113
6,333,485 B1 * 12/2001 Haight et al. 219/121.68
6,365,443 B1 * 4/2002 Hagiwara et al. 438/110
6,376,797 B1 * 4/2002 Piwczyk et al. 219/121.72
6,440,773 B1 * 8/2002 Usami 438/107**FOREIGN PATENT DOCUMENTS**JP 55046579 A * 4/1980 H01L/21/66
JP 55151351 A * 11/1980 H01L/21/78
JP 05166926 A * 7/1993 H01L/21/78

* cited by examiner

Primary Examiner—George Fourson*Assistant Examiner*—Michelle Estrada**(74) Attorney, Agent, or Firm—J. C. Patents****(57) ABSTRACT**

A substrate, such as a semiconductor wafer, is cut without using a dicer or an adhesive sheet.

A semiconductor wafer 1 formed with a number of elements 2 is drawn and held by an x-y table 4, and ultrashort pulse laser 7 having a pulse width of not more than 1 picosecond is irradiated along scribed lines between the elements 2 to cut the same.

15 Claims, 13 Drawing SheetsUSPS EXPRESS MAIL
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